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Research Article

THE INFLUENCE OF GENERIC SKILLS ON GENDER DIFFERENCES IN SCIENTIFIC PROCESSING AND CRITICAL THINKING IN PHYSICS MOTION DYNAMICS

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Abstract
This study investigates the gender differences in generic skills, scientific process abilities, and critical thinking among high school students during physics learning, specifically within motion dynamics. The research aims to uncover the impact of generic skills on students' scientific processing and critical thinking abilities while examining how gender influences these cognitive domains. Employing a comparative quantitative research design, data were gathered from 180 students (90 male and 90 female) in Jambi City using observation sheets, test questions, and questionnaires. The sample was selected through simple random sampling, and statistical analyses were performed to examine the differences in learning outcomes between genders. Results revealed notable gender disparities in generic skills, scientific processing, and critical thinking, with male and female students demonstrating distinct proficiencies in physics learning. This underscores the necessity of adopting gender-sensitive educational approaches to foster equitable learning experiences. The uniqueness of this research lies in its detailed exploration of the interconnectedness between generic skills, scientific processing, and critical thinking within the framework of gender. Unlike prior studies, which often focus on isolated skills, this study integrates these core competencies to provide a more holistic understanding of how gender influences physics learning. The findings emphasize the need for inclusive curricula and gender-tailored instructional strategies that promote equal opportunities for all students in science education, particularly in physics, thus contributing to a more balanced and equitable academic environment.

Keywords: Critical Thinking Ability, Dynamics of Linear Motion, Gender, Generic Science Skills, Science Process Skills

INTRODUCTION

In the realm of science education, understanding the interplay between students' generic skills, scientific processing abilities, and critical thinking is crucial for fostering effective learning outcomes.

This research explores the influence and comparison of students' generic abilities on scientific processing and critical thinking abilities, with a special focus on teaching material on the dynamics of rectilinear motion in physics (Lin, & Schunn, 2016; Sarkar et al., 2019; Nahar, 2024; Putri, & Turaqulov, 2022; Jusmaniar et al., 2024). Moreover, it scrutinizes these dynamics through the lens of gender, recognizing the potential disparities that may exist in academic achievement and skill development.

Generic skills, encompassing communication, collaboration, problem-solving, and information literacy, serve as foundational competencies that underpin academic success across various disciplines (Virtanen & Tynjälä, 2019; Denton et al., 2020; Suwarni, 2021; Tushar & Sooraksa, 2023; Yohanie et al., 2023). Within the domain of physics education, where complex concepts and analytical thinking are paramount, the integration of these generic skills can significantly impact students' comprehension and application of scientific principles (Kusuma, 2020; Liang et al., 2023; Jamil et al., 2024; Wati et al., 2024). Scientific processing skills represent the capacity to engage with scientific content, conduct experiments, analyze data, and draw conclusions a fundamental aspect of scientific inquiry (Georgiou et al., 2021; Dessi & Shah, 2023; Mulyati et al., 2023). Similarly, critical thinking is a cognitive process characterized by objective analysis, logical reasoning, and the evaluation of evidence, all of which are integral to effective problem-solving and decision-making (Çelik & Özdemir, 2020; Hyytinen et al., 2021; Irawati & Putri Ningsi, 2021; Dessi, & Shah, 2023; Apeadido et al., 2024).

However, while the importance of these skills is widely acknowledged, their manifestation and development may vary across student demographics, including gender (Monterrosa et al., 2020; Nursakinah & Jauhar, 2023; Saputro et al., 2023; Habibi, Jiyane, & Ozsen, 2024; Khasawneh, 2024). Research has shown that gender differences can influence learning behaviors, preferences, and outcomes, potentially leading to variations in academic performance and skill acquisition. Therefore, this study aims to address this gap by investigating how students' general skills impact their proficiency in scientific processing and critical thinking, specifically in the context of learning ldynamics of rectilinear motion in physics. Furthermore, it seeks to compare these skill levels between male and female students, shedding light on potential gender-related disparities in skill development and academic achievement.

By exploring these dynamics, this research endeavors to contribute valuable insights to both the fields of science education and gender studies (Iwuanyanwu, 2022; Asrial et al., 2023; Azuratunnasuha, 2023; Octavia et al., 2023; Rinjani, & Romadona, 2023). Understanding the nuanced interactions between generic skills, scientific processing abilities, and critical thinking, as well as their differential effects based on gender, is essential for designing tailored educational interventions and fostering equitable learning environments (Alam & Mohanty, 2023; Asrial et al., 2023; Herawati, Khairinal, & Idrus, 2023; Rico et al., 2023; Putri & Mufit, 2023; Essien et al., 2024). Through this exploration, we endeavor to enhance the effectiveness and inclusivity of physics education, empowering all students to excel in their scientific pursuits.

Previous research has highlighted the importance of generic skills in higher education, especially in relation to the development of job-oriented professional skills (Deta et al., 2020; Lin, Hu, & Chiu, 2020; Tuononen et al., 2022). However, there is a lack of consistency in conceptualization and methodology in measuring these skills, as well as a lack of focus on higher-order thinking skills and more comprehensive longitudinal studies. In addition, previous research has focused more on contextual factors influencing generic skills learning rather than individual factors. The current study contributes by extending the focus on generic skills to the secondary education level, specifically in the context of physics learning. Unlike previous research, this study also pays special attention to gender differences, which have not been widely addressed in previous research, and links generic skills to scientific processing and critical thinking abilities. Thus, this study fills the gap in previous research by highlighting the role of individual factors such as gender in the acquisition of generic skills and scientific skills at earlier levels of education.

This research explores the influence and comparison of students’ generic skills on science processing and critical thinking skills, with a focus on the physics learning material Dynamics of rectilinear motion. This is a new contribution in understanding how generic skills can influence students' ability to understand and apply physics concepts especially to specific topics. This research can provide a deeper understanding of the factors that influence students' science processing and critical thinking skills, especially in the context of physics learning. The results of this research can provide a basis for developing more effective learning strategies in improving these skills. Additionally, a better understanding of gender differences in the influence of generic skills can also help in identifying and addressing disparities in academic achievement between male and female students.

The urgency of this research lies in the need to understand the factors that influence students' ability to understand and apply scientific concepts, especially in the field of physics. Generic skills, such as critical thinking abilities, are important aspects of the learning process that can influence students' academic achievement. This research will help in understanding the extent to which students' generic skills, such as communication, collaboration, and problem-solving abilities, influence their ability to understand physics material. This is important to form appropriate learning strategies to improve student understanding. The main aim of this research is to examine the influence of students' generic skills on science processing and critical thinking skills, taking into account gender differences, especially in the context of learning the physics of rectilinear rotational dynamics. Apart from that, this research also aims to compare the skill levels between male and female students in terms of generic skills, science processing, and critical thinking.

RESEARCH METHOD

The research design used is a Comparative Quantitative Research Design. This design makes it possible to compare the average or mean scores between male and female groups on generic skills, science process skills, and critical thinking abilities.

The population in this study were high school students in Jambi City. The sampling technique in this research used simple random sampling. Simple random sampling technique is a sampling method where each individual in the population has an equal chance of being selected to be part of the sample. So the samples in this study were students in class F3 of State 12 High School, Jambi City, F2 of State 10 High School, Jambi City, and F2 of State 6 High School, Jambi City with a sample size of 180 students, where 30 female students were taken from each school. and 30 male students.

The instruments used in this research were student generic skills observation sheets, science process skills observation sheets, critical thinking skills test questions and student response questionnaires. Research instruments are tools that are needed or used to help collect data in the field (Rini et al., 2021). The science process skill observation sheet is used to find out and observe student activities during practicum activities. Science process skills are categorized into two types: basic science process skills and integrated science process skills. Basic science process skills include observing, classifying, communicating, measuring, inferring, and predicting. Integrated science process skills encompass identifying variables, creating data tables, making graphs, describing relationships between variables, obtaining and processing data, analyzing investigations, forming hypotheses, describing variables operationally, designing experiments, and conducting experiments. Table 1 provides an assessment grid for evaluating these science process skills.

Table 1. Science Process Skills Assessment Grid

Indicator Science Process Skills	Items
Observing	4
Classifying	4
Communicating	4
Measuring	3
Inferring	4
Predicting	5
Identifying variables	6
Creating data tables	2
Making graphs	3
Describing relationships between variables	4
Obtaining and processing data	5
Analyzing investigations	6
Making hypotheses	4
Describe variables operationally	3
Design experiments	4
Conduct experiments	5
Total	66

The science process skill score, assessed using a Likert scale, includes four categories: 1 = not good, 2 = quite good, 3 = good, and 4 = very good. This score evaluates student activity during practical sessions. Additionally, critical thinking ability test questions are used to measure student learning outcomes following the practical activities. The test consists of an essay format with a total of 5 questions, administered to students after the completion of the practicum to gauge their understanding of the material covered. Table 2 presents the questionnaire for assessing students' generic science skills.

Table 2. Table of indicators of Science Generic Skills

Aspects of Generic Science Skills	Indicator	Items
Direct Observation	Using as many senses as possible in observing natural phenomena experiments	2
	Collecting facts from experiments/observations	2
	Look for differences and similarities	2
Indirect observation	Using measuring instruments as sensory aids in observing natural phenomena experiments	2
	Gather facts from physics experiments or natural phenomena	2
	Look for differences and similarities	2

Based on table 2, it is known that the students' generic science skills questionnaire is divided into 2 aspects, namely direct observation and indirect observation with a total of 12 statement items. The categories for each variable in this study are presented in table 3 below:

Table 3. Variable categories of science generic skills, science process skills and students' critical thinking abilities

Category	Science generic skills	Science process skills	Critical thinking critical thinking
Not good	12- 23	66-115.5	5- 23.75
Enough	24 - 34	115.6-165.0	23.76 - 42.50
Good	35 – 45	165.1-214.5	42.51 – 61.25
Very good	46 - 56	214.6-264.0	61.26 - 80.0

The data obtained is analyzed using both descriptive and inferential statistical techniques. Descriptive statistics are used to visually or contextually present data, employing images and calculations to summarize or describe the dataset (Gibbons & Chakraborti, 2013). In the inferential statistical test, two tests are carried out, namely the assumption test and the hypothesis test. Descriptive statistics are used to obtain mean, median, mode, maximum and minimum values. This technique is used to describe research results related to science process skills. After analyzing descriptive data, the next step is to process the data using inferential statistical analysis. This inferential analysis was carried out to determine the influence of students' generic science skills on science process skills, and the influence of generic science skills on critical thinking skills. Inferential statistics are statistics used to analyze sample data and the results will be generalized or concluded for the original population if the assumptions used are normality, homogeneity and linearity tests. The normality test is carried out to determine whether the data obtained is normally distributed or normally distributed. In the inferential statistical test, two tests are carried out, namely the assumption test and the hypothesis test. The assumption tests used are normality, homogeneity and linearity tests. The normality test is carried out to determine whether the data obtained is normally distributed or normally distributed. To guide decision making in this normality test, namely the Sig value. or the significance or probability value is > 0.05, then the distribution is normal. The next test that needs to be carried out is a homogeneity test to determine the variance of the data. The linearity test is carried out to find out whether the data obtained is linear or not. To guide decision making in the homogeneity test and linearity test, namely by looking at the significance value, if the significance value is > 0.05 then the data obtained is homogeneous and linear. After testing assumptions, the next step is to test the hypothesis. Hypothesis testing was carried out using the independent sample t-test along with further post hoc Tukey tests and simple linear regression tests.

RESULTS AND DISCUSSION

Generic science skills are an important component that must be instilled in students to develop a thorough understanding of science. Through these skills, students can observe carefully, analyze critically, and communicate information clearly. In addition, it is also important for students to have science process skills. Science process skills are one of the skills that must be mastered by students with the aim of helping develop students' critical thinking skills. The scientific process skill indicators to be measured consist of 3 indicators, namely observation, classification and communication. Based on this, a descriptive analysis test will be conducted first. In this descriptive statistical analysis, the ways of presenting data can be in the form of tables or diagrams, determining the average value (mean), the value that occurs frequently (mode), the median value (middle value), determining the range, minimum value and maximum value of data. The following descriptive table of science process skills p is presented in table 4.

Table 4. Description of Science Process Skills.

Interval	Category	Mean	Med	Mode	Min	Max	F	%	Gender
66.0 – 115.5	Not good	166.5	166.0	180.0	116.0	214.0	-	-	Man
115.6 – 165.0	Enough						40	22.2%	
165.1 – 214.5	Good						140	77.8%	
214.6 – 264.0	Very good						-	-	
66.0 – 115.5	Not good	178.9	175.00	179.0	117.0	217.0	-	-	Women
115.6 – 165.0	Enough						38	21.1%	
165.1 – 214.5	Good						140	77.8%	
214.6 – 264.0	Very good						2	1.1%	

Based on Table 4, it is clear that the majority of male students' science process skills are rated as 'good,' with 77.8% achieving this level. The statistical details for male students show a mean score of 166.5, a median of 166.0, a mode of 180.00, a minimum score of 116.00, and a maximum score of 214.00. Similarly, 77.8% of female students also fall into the 'good' category. Their statistical details include a mean score of 178.9, a median of 175.00, a mode of 179.00, a minimum score of 117.00, and a maximum score of 250.00. The results of the data analysis on high school students' critical thinking abilities are presented in Table 5.

Table 5. Description of students' critical thinking abilities

Interval	Category	Mean	Med	Mode	Min	Max	F	%	Gender
5- 23.75	Not good	50.5	51.0	59.00	42.00	75.00	-	-	Man
23.76 - 42.50	Enough						37	20.6%	
42.51 – 61.25	Good						140	77.8%	
61.26 - 80.0	Very good						3	1.6%	
5- 23.75	Not good	51.5	52.5	60.00	45.00	74.00	-	-	Women
23.76 - 42.50	Enough						40	22.2%	
42.51 – 61.25	Good						135	75%	
61.26 - 80.0	Very good						5	2.8%	

Based on Table 5, it is evident that the critical thinking skills of male students predominantly fall into the 'good' category, with 77.8% achieving this level. The statistical details for male students include a mean score of 50.5, a median of 51.0, a mode of 59.00, a minimum score of 42.00, and a maximum score of 75.00. Similarly, 75% of female students are also in the 'good' category. For female students, the mean score is 51.5, the median is 52.5, the mode is 60.00, the minimum score is 45.00, and the maximum score is 75.00. The results describing students' generic science skills are presented in Table 6.

Table 6. Description of students' generic science skills

Interval	Category	mean	median	Mode	Min	Max	F	%	Gender
12- 23	Not good	41.5	45.0	35.00	34.00	55.00	1	0.5%	Man
24 - 34	Enough						38	21.1%	
35 – 45	Good						139	72.2%	
46 - 56	Very good						2	1.1%	
12- 23	Not good	39.5	41.5	50.00	35.00	44.00	3	1.7%	Women
24 - 34	Enough						39	21.7%	
35 – 45	Good						133	73.9%	
46 - 56	Very good						5	2.8%	

Based on table 6, it can be seen that male students' critical thinking skills are dominant in the good category with a percentage of 72.2% with a mean value of 41.5, median 45.0, mode 35.00, minimum value 34.00 and maximum value 55.00. Meanwhile, female students are in the good category with a percentage of 73.9% with a mean value of 39.5, median 41.5, mode 50.00, minimum value 35.00 and maximum value 44.00. Next, assumption tests are carried out in the form of normality, homogeneity and linearity tests. First, the normality test results will be presented which are presented in table 7 below.

Table 7. normality test results Kolmogorov-smirnov

	Kolmogorov-Smirnov	
	N	Sig.
Science process skills	180	.200
Generic science skills	180	.300
Critical thinking skills	180	.260

Based on the results of data analysis using Kolmogorov-Smirnov with the help of SPSS software, data was obtained on students' science process skills, students' movement skills and students' critical thinking abilities in physics learning, material on dynamics of rectilinear motion in class F5, State High School 12, Jambi City, F4, State High School 11. Jambi City, and F2 State High School 6 Jambi City obtained a significance value of > 0.05. So, from the results of the data analysis, a decision can be made that data on students' science process skills, students' movement skills and students' critical thinking abilities in physics learning material on the dynamics of rectilinear motion in class F5, State High School 12, Jambi City, F4, State High School 11, Jambi City, and F2 State Senior High School 6 Jambi City has normal distribution. Next, a data homogeneity test was carried out, presented in table 8.

Table 8. homogeneity test

Variable	School	Sig.
Science process skills	State High School 11 Jambi City	.110
	State High School 12 Jambi City	.130
	Jambi City State High School 6	.200
Generic science skills	State High School 11 Jambi City	.130
	State High School 12 Jambi City	.200
	Jambi City State High School 6	.190
Critical thinking skills	State High School 11 Jambi City	.230
	State High School 12 Jambi City	.220
	Jambi City State High School 6	.220

Based on table 8, it is found that the data is homogeneous as indicated by the sig value for each variable in each school > 0.05. Next, the linearity test of the research data is presented in table 9.

Table 9. Description of variable linearity test. Science process skills, generic science skills and critical thinking abilities

Variable	Sig.	Description
Science process skills * Generic science skills	.100	linear
Generic science skills* Critical thinking ability	.110	linear
Critical thinking skills* Science process skills	.200	linear

Based on table 9, it is found that the data is linearly related as indicated by the sig value for each variable > 0.05. Next, there is a comparative test (independent simple t-test) of variable research data. Science process skills, generic science skills and students' critical thinking abilities in physics learning material on dynamics of rectilinear motion in class F5, State 12 High School, Jambi City, F4, State 11 City High School. Jambi, and F2 State High School 6 Jambi City are presented in table 10.

Table 10. Anova test of female students' generic science skills on students' science process skills and critical thinking abilities

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	68656754666	2	34328377333	3.873	0.027
Within Groups	1.857E+11	88	8840990696		
Total	2.543E+11	90			

Based on table 10, it is found that in the Sig column. obtained P value (P-value) = 0.027. And it can be seen from the calculated F value of 3.873 and the F table value of 3.10, so the F calculated value is more than the F table value. Thus, at the real level = 0.05 we reject Ho, so the conclusion obtained is that there is a significant difference in the average generic skills of students based on gender, namely female students in each of these schools. Next, a descriptive ANOVA table of students' generic science skills is presented on the science process skills and critical thinking abilities of female students.

Table 11. Descriptives ANOVA test of female students' generic science skills on science process skills and critical thinking abilities

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
SPS	90	193497.50	58801.595	20789.503	146238.14	244656.86	100000	252330
CTS	90	321423.25	97331.637	34411.930	245051.97	407794.53	231133	552330
Total	180	264333.83	105153.627	21464.394	217931.35	306736.32	100000	552330

From the Descriptives table it appears that female student respondents averaged 193497.50 for science process skills and female students' critical thinking skills averaged 321423.25. Next, to see further tests, you can see the ANOVA table. To determine which further test to use, we again look at the Test of Homogeneity of Variances table. If the test results show the same variance, then the further test used is the Bonferroni test. However, if the test results show that the variants are not the same, then the further test used is the Benferroni test, a post-hoc further test.

Table 12. Post-hoc further test of female students' generic science skills on science process skills and critical thinking abilities

	(I) Model	(J) Model	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Benferroni	GSS	SPS	10.69	2.900	0.022	-191881.22	52714.72
		CTS	53.86	2.900	0.026	-253223.72	-8827.78
	SPS	GSS	10.69	2.900	0.027	-52714.72	191881.22
		CTS	43.17	2.900	0.026	-183640.47	60955.47
	CTS	SPS	53.86	2.900	0.037	8627.78	253223.72
		GSS	43.17	2.900	0.042	-60955.47	183640.47

The basis for decision making in this ANOVA test is that if the significance value is > 0.05 then there is no influence between the independent variable and the dependent variable, conversely if the significance value is < 0.05 then there is an influence between the independent variable and the dependent variable. Based on the table above, it can be said that there is an influence between students' generic science skills on science process skills and students' critical thinking abilities, it can be seen that the sig value is > 0.05.

Table 13. Anova test of male students' generic science skills on students' science process skills and critical thinking abilities

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	68656754666	2	34312377333	3.543	0.018
Within Groups	1.857E+11	88	88409190696		
Total	2.543E+11	90			

Based on table 13, it is found that in the Sig column. The obtained P value (P-value) = 0.018 and it can be seen that the F count is 3.543 and the F table value is 3.10 so that the F count value is more than the F table value. Thus, at the real level = 0.05 Ho is rejected, so the conclusion obtained is that there is a difference which means the average generic skills of students based on gender, namely male students in each school. Next, a descriptive ANOVA table of students' generic science skills is presented on the science process skills and critical thinking abilities of male students.

Table 14. Descriptives ANOVA test of male students' generic science skills on science process skills and critical thinking abilities

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
SPS	90	175497.50	58801.595	20789.503	146238.14	244656.86	100000	252330
CTS	90	310142.25	97331.637	34411.930	245051.97	407794.53	231133	552330
Total	180	264333.83	105153.627	21464.394	217931.35	306736.32	100000	552330

From the Descriptives table it appears that male student respondents averaged 173497.50 for science process skills and female students' critical thinking skills averaged 310142.25. Next, to see further tests, you can see the ANOVA table. To determine which further test to use, we again look at the Test of Homogeneity of Variances table. If the test results show the same variance, then the further test used is the Bonferroni test. However, if the test results show that the variants are not the same, then the further test used is the Benferroni test, a post-hoc further test.

Table 15. Post-hoc further test of male students' generic science skills on science process skills and critical thinking abilities

	(I) Model	(J) Model	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Benferroni	GSS	SPS	10.19	2.900	0.022	-191881.22	52714.72
		CTS	53.86	2.900	0.036	-253223.72	-8827.78
	SPS	GSS	10.29	2.900	0.037	-52714.72	191881.22
		CTS	43.17	2.900	0.016	-183640.47	60955.47
	CTS	SPS	53.26	2.900	0.017	8627.78	253223.72
		GSS	43.37	2.900	0.022	-60955.47	183640.47

The basis for decision making in this ANOVA test is that if the significance value is > 0.05 then there is no influence between the independent variable and the dependent variable, conversely if the significance value is < 0.05 then there is an influence between the independent variable and the dependent variable. Based on the table above, it can be said that there is an influence between students' generic science skills on science process skills and male students' critical thinking abilities. It can be seen that the sig value is <0.05. Next, the results of the influence test, namely simple linear regression, are presented in table 16.

Table 16. Simple linear regression test results

Variable	R	R Square	Sig.
Generic science skills* Science process skills	0.655	0.43	0.01
Generic science skills* Critical thinking ability	0.700	0.49	0.03

Based on the table of simple linear regression test results above, it can be seen that there is an influence of students' generic science skills on students' science process skills with a significant influence of 43%. Furthermore, there is an influence of students' generic science skills on students' critical thinking abilities with a significant influence of 49%.

The results of this research show that there are significant differences in students' abilities in various aspects between high schools in Jambi City. Based on data analysis, there are significant differences between generic science skills, critical thinking abilities, and science process abilities between male and female students in learning physics on the dynamics of rectilinear motion. The results of Tukey's post hoc further test showed that the difference was quite significant, with a significance value of less than 0.05. In terms of generic science skills, women have a slightly higher average score than men, although the difference is not that big. However, in critical thinking skills, male students show slightly higher scores than female students. Meanwhile, in terms of scientific process abilities, women have higher scores than men.

Furthermore, the analysis results indicate a significant relationship between students' generic science skills, science process abilities, and critical thinking skills. The linearity test shows a notable linear relationship between these variables, with a considerable influence of 43% and 49%, respectively. These findings underscore the importance of emphasizing science education for both genders by adapting teaching methods and curricula to enhance students' learning potential. Additionally, this research highlights the necessity of considering individual learning differences to achieve optimal outcomes. Consistent with previous research, data analysis using SPSS reveals that students with high levels of creativity significantly enhance their generic science skills (Razali et al., 2020). In general, the contributions of previous research are in line with the current research in the sense that both aim to increase understanding of students' skill development in science. Previous research results show that programs such as BIL can be effective in improving students' generic skills (Dewi et al., 2020). This contribution is in line with current research which also highlights the importance of generic science skills and critical thinking abilities in science learning.

In line with the results of previous research which found that students' science process skills influence critical thinking in natural science learning (Tanti et al., 2020). Based on previous research, it is also known that the comparison of students' science process skills and critical thinking based on school location shows that in urban areas it is higher than in rural areas. The results of previous research support the research results found in this study, namely that male and female students have science process skills, critical thinking skills and generic science skills which are predominantly in the good category. Previous research also found that generic skills are part of learning skills that are applied to new and different situations, especially to certain principles in the learning process. Students' abilities increase due to changes in the process (Riza et al., 2022; Utami et al., 2023; Zakiyah, Boonma, & Collado, 2024). From previous research it is known that generic science skills provide opportunities for students to be actively involved in learning so that interactions occur between skills and concepts, principles and theories that have been discovered or developed. The results of previous research found that the use of the guided inquiry learning model has the ability to significantly improve students' understanding of concepts as well as their critical thinking abilities compared to conventional learning (Darmaji et al., 2020; Maknun, 2020; Wayan Santyasa et al., 2021; Rahmawati et al., 2023; Fitriana & Waswa, 2024). Then, previous research also found that integrating games in the physics learning process can improve students' critical thinking abilities. From previous research it is known that the scientific process experienced by students in the learning process can have a positive impact on students, varied learning models and interesting teaching strategies are needed to develop students' skills.

The novelty of this research lies in the comprehensive analysis that combines science process skills, science generic skills, and students' critical thinking abilities in physics learning. This research not only identified significant differences based on gender in these three skill areas, but also evaluated the linear relationship between generic science skills with science process skills and critical thinking abilities. With this approach, this research provides a holistic view of the interactions between these skills and their impact on student learning. In addition, the use of extensive statistical methods and contextualization of results in the educational setting in Jambi City offers new insights that can be specifically applied in regional education policy and practice. The practical implications of these findings, such as recommendations for adapting teaching methods and curricula based on gender and ability differences, also add novel value to this research in efforts to improve the quality of science education. From the results of this research, learning innovations must be carried out.

This research brings an important breakthrough in the understanding of science learning in high schools, especially in the context of physics learning on the dynamics of rectilinear motion in Jambi City. These findings reveal that there are significant differences between the abilities of male and female students in the aspects of generic science skills, critical thinking abilities, and science process abilities. This highlights the importance of considering gender in curriculum development and teaching strategies, and emphasizes the need for inclusive approaches in science education (Wright & Delgado, 2023). In addition, this research also identified a significant relationship between students' generic science skills and science process abilities and critical thinking, which shows the potential for developing a more holistic and integrated learning approach. These results provide a basis for efforts to improve the quality of science education at the upper secondary level, by paying attention to students' individual differences and creating a learning environment that supports their holistic growth.

The implication of this research is the importance of recognizing gender differences in science learning in high schools. These findings highlight the need for learning strategies that are more inclusive and sensitive to the needs and potential of individual students, regardless of their gender. Developing curricula and teaching methods that take gender differences into account can help create a more equitable and supportive learning environment for all students. However, this research also has several limitations that need to be considered. First, this research was only conducted in Jambi City, so the generalization of the findings is limited to that context. In addition, the use of certain research methods, such as linearity tests and comparison tests, can influence the results of data analysis and interpretation. Therefore, further research involving wider samples and varied contexts is needed to validate these findings in more depth.

CONCLUSION

This study found significant differences between generic skills, critical thinking skills, and science process skills in male and female students in physics learning about linear motion dynamics. Male students showed higher results in critical thinking, while female students excelled in generic skills and science processes. These findings emphasize the importance of considering gender differences in the development of inclusive curriculum and learning strategies. The implication of this study is the need for teaching strategies that are more sensitive to the individual needs of students based on gender to create a more equitable learning environment and support students' holistic growth. In addition, this study shows that generic skills have a significant influence on science process skills and critical thinking, which offers opportunities for learning innovations to develop a more holistic and integrated approach.

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AUTHOR CONTRIBUTIONS

For research articles with several authors, a short paragraph specifying their individual contributions must be provided. The following statements should be used “Conceptualization, A and D; Methodology, ET; Writing – Original Draft Preparation, A.; Writing – Review & Editing, D, K”.

CONFLICTS OF INTEREST

The author(s) declare no conflict of interest.

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